Syllabus for Corrosion Science and Engineering, MSNE 569
Rice University spring 2022 January 12, 2022

1. Instructor: Dr. Randy C John
   - His office is in the MSNE department office in the second floor of George R Brown Hall
   - email is johnrandy14@yahoo.com or randy.john@rice.edu
   - cell phone is 281-620-3998
   - Course will be 100% online during the first two weeks and then transition to face to face. Dr. John can be reached by phone and discussions held via Zoom. Good times for phone calls are 11:00 – 12:00 and 1:30-3:00 p.m. Mondays, Wednesdays and Fridays.
2. Class will begin meeting online at 1:00 – 2:20 p.m. on Mondays and Wednesdays, before transitioning to face to face for the same meeting schedule in several weeks, after guidance from Rice leadership is given. An alternate class day/time may be used in the event class is not held on a scheduled day (except for days affected by University-wide cancellation of classes). If Dr. John cannot attend a regular class meeting, an alternate will be scheduled.
3. Students are welcome to visit with Dr John. Feel free to call or email. Discussions on course contents or career issues are welcome.
4. Course objectives for the students are to learn the basics of the science of corrosion and to become familiar with typical applications in industries. Topics to be discussed and to be mastered include awareness and understanding relating to the following:
   - Industrial examples of failed corrosion strategies and the consequences
   - half-cell reactions, anode, cathode, faraday's law, corrosion units, 8 forms of corrosion
   - electrolytes, interfaces, double layer, electrode potential, reference electrodes. measurements
   - thermodynamics review, free energy, Gibbs' energy, chemical potential, Nernst equation
   - thermodynamics of corrosion, electrochemical cells, galvanic corrosion, (fuel cells and batteries)
   - aqueous - Pourbaix diagram calculations, water, metals with water, alloy examples, limitations with corrosion
   - aqueous - kinetics, weight change, measurement methods, polarization, anodic/cathodic protection
   - aqueous - passivity, theories, surface analysis, effects of alloying elements
   - aqueous - crevices, pitting, occluded cells and mechanical aspects, stress corrosion cracking forms
   - aqueous - inhibitors, acids, neutral solutions, and coatings (nano applications)
   - gases - thermodynamics, phase diagrams, phase stability diagrams, electrochemistry, testing
   - gases - forms of corrosion (carburization, nitridation, HTHA, oxidation, sulfidation, molten salts, molten phases, halogens, mixed mode)
   - examples of corrosion from several industries
5. Homework will be **all problems** at the end of each chapter, will be neat and will be submitted to the instructor at the beginning of the first class of the following week and multiple sheets will be submitted together. Paper size 8.5 x 11.0 inches is required for

homework. Scan and email the homework answers to Dr. John at randy.john@rice.edu, with all pages in the same pdf file. Homework is due at the beginning of the class period. Late work will not be graded, unless approval is given before the homework is due.

Additional homework, each student will provide a table of melting points and costs/pound or kg , due September 7.

Expected learning outcomes for the student are to learn the vocabulary and analysis tools to define the key aspects of a corrosion situation, to recommend a course of action for analysis and to suggest a plan for remediation.

6. Grade policies
   - All materials to be graded should be presented to the instructor on the due date announced.
   - Materials should be submitted no later than the beginning of class time of the due date announced.
   - Exceptions for late submissions should be discussed with the instructor before the due date.
7. Absence policy
   - Students are expected to attend all classes.
   - Regular attendance and productive/positive class participation may influence final course grades. Not all materials presented are found in the textbook.
8. Required textbook
   Introduction to Corrosion Science by E. McCafferty
   Hardcover: 302 pages
   Publisher: Springer; 2010 edition (May 11, 2010)
   Language: English
   E books and paper books are available with costs of $86 – 90.
   ISBN-13: 978-1441904546 ISBN-10: 1441904549
   Some links for purchases are below.
   https://www.amazon.com/Introduction-Corrosion-Science-Edward-McCafferty/dp/1441904549
   https://www.springer.com/gp/book/9781441904546
   https://b-ok.cc/book/939774/c33d3e?dsource=recommend
9. Special materials required for the class
   - none
10. Required examinations and papers
    - Final is a collaborative team presentation project. Project will include a package of presentation pdf slides and a team oral presentation, topics and teams will be assigned by instructor – 25%
    - Two course exams, in class – 25% for each exam
    - One quiz, in class – 10%
    - Exams will be in class and tend to be long. Check for commitments at end of class.
    - Homework items from each chapter discussed in the course and submitted at beginning

of the first class of the following week and extra items requested and tend to appear on exams – 15%
- Course schedule is attached below as a table.
- Each class before each exam will be a review.

11. Statement of expectations regarding course work and the Rice Honor Code
    - Homework assignments may be done in collaboration with student colleagues
    - Cell phones and electronic communication devices will be switched off during class time.
    - Exams in class time are expected to be individual efforts, shall not involve collaboration with students and may not include use of any resources not approved
    - The final team project assignment will be done in collaboration with team colleagues and individual contributions will be identified. Team project grade will include equally weighted portions of individual contribution and teamwork contributions.
    - All course work should be of high quality in presentation and information contained; should indicate the assignment; should show the logical assessment of the problem statement, the analysis done, the final conclusion/recommendations; and full reference citations of all background/source materials used in the effort.
    - Materials submitted for course requirements will be neat, orderly, complete, well prepared and submitted on the required date, unless alternate arrangements were made before the due date.
    - Survey of course/instructor performance will be done at course mid-point.
    - The Rice honor code shall apply.
12. Any student with a disability that requires accommodation should contact both the course instructor and Disability Support Services in the Allen Center.
13. Information contained in this course syllabus, other than the absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor and announced to the students.
14. Students needing special accommodations to due physical limitations are encouraged to communicate this need to the instructor as soon the need becomes known to the student. The intent is to comply with the ADA statute.
15. Chapters in the textbook should be read in advance of the week's lectures.
16. Estimate of 2-3 hours of personal study/homework time for each hour in class.

To address ABET student outcomes and program criteria, the students will have

(a) An ability to apply knowledge of knowledge of mathematics, science and engineering
(b) An ability to identify, formulate and solve engineering problems

The curriculum will prepare graduates to apply advanced science (such as chemistry, biology and physics), computational techniques and engineering principles to materials systems implied by the program modifier, e.g. ceramics, polymers, biomaterials, composites materials; The subject materials specific to this course will be corrosion science and the application of these principles to corrosion engineering materials principles in industrial applications. Graded student materials for the team project will demonstrate completion of the above requirements.

Schedule for Corrosion Science and Engineering MSNE 569 at Rice University spring 2022 (April 5, 2022)							
	Monday	Week	Book Chapter	Homework due	Corrosion engineering class content, lectures	Exams	Course grade weight
ntroductior	Jan. 10	1	1	Jan. 19	why, what, how, Periodic table, alloying elements, major engineering alloy families (Fe, Ni, Al, Cu, Ti, Co, Pb, Zn), simple metal costs and melting points		
chemistry	Jan. 17	2	2	Jan. 24	half cell reactions, anode, cathode, faraday's law, units, 8 forms of corrosion		
	Jan. 24	3	3	Jan. 31	electrolytes, interfaces, double layer, electrode potential, reference electrodes. Measurements		
	Jan. 31	4	4	Feb. 7	thermodynamics review, free energy, Gibbs' energy, chemical potential, Nernst equation	quiz	10%
	Feb. 7	5	5	Feb. 14	thermodynamics of corrosion, electrochemical cells, galvanic corrosion, (fuel cells and batteries)		
aqueous corrosion	Feb. 14	6	6 and extra diagrams	Feb. 21	Pourbaix diagram calculations, water, metals with water, alloy examples, limitations with corrosion		
	Feb. 21	7	7	Feb. 28	kinetics, weight change, measurement methods, polarization, anodic/cathodic protection		
	Feb. 28	8	8	Mar. 7	concentration polarization and diffusion and passivity, theories, surface analysis, effects of alloying elements		
	Mar. 7	9	9	Mar. 21	passivity, theories, surface analysis, effects of alloying elements		
	Mar. 12 - 20				spring break		
	Mar. 21	10	10	Mar. 28	crevices, pitting, occluded cells and mechanical aspects, stress corrosion cracking forms, distribute group project assignments	midterm 1 and assign projects	25%
	Mar. 28	11	11	Apr. 4	Monday - Mechanically induced corrosion cracking		
gas phase corrosion	Apr. 4	12	12 and 13	Apr. 11	Monday - corrosion inhibitors, acids and neutral solutions Wednesday - coatings		
	Apr. 11	13	15	Apr. 18	Monday - high temperature gaseous oxidation, thermodynamics, phase diagrams, phase stabilty Wednesday - Monday - high temperature corrosion (carburization, nitridation,	team report drafts 4/8	
	Apr. 18	14	extra - RCJ article		Monday - mixed mode, Wednesday - exam	midterm 2	25%
corrosion in industry	Apr. 25				lectures on oil/gas/refining and nuclear power generation (water treatment and steam turbines) and team presentations	class presentations	25%
			homework				15%
Each team project will analyze an industrial corrosion situation, broken into pieces for each student, prepare an assessment summarized in a presentation with background, summary of major issues and recommended mitigation plan approach: assign task, review at midpoint and 25 minutes presentation in class. Homework is							
						total grade	100%